THE INFLUENCE OF FROZEN STORAGE TEMPERATURE VARIATION ON THE DRIP LOSS IN BROILER

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Introduction

Broiler meat plays an important role on both Brazilian diet, as cheap protein source, and economy as one of the largest exporting meat products, placing the country as first world broiler meat exporter. In order to maintain its quality, good storage conditions must exist. It's known that variations on frozen storage temperature can cause quality loss, especially concerning drip losses after thawing due to ice crystal growth and recrystallization (Bevilacqua and Zaritzky, 1982). The resulting lost fluids, in general, reduces the Water Holding Capacity (WHC) of the meat, its sensorial and nutritional qualities, as well its weight (Ngapo et al., 1999).

The Brazilian cold chain has many problems concerning its logistics, like roads and railroads on bad conditions and lack of frost storage space, obsolete equipment and low investments. (Borré and Agito, 2005). There's also a wrong consumer culture regarding the correct conservation of frozen meat at home. Beside all this facts, the country has a very big geographic area and tropical climate, with average temperatures on summer months above 35°C (Maliverni, 2004). All these conditions create temperatures variations during transport and sales, which can lead to increasing drip losses. High drip loss value, especially above 6% of the broiler carcass net weight is forbidden by Brazilian law (Brazil, 1998) as excess of water absorption during *post mortem* refrigeration process. The objective of the present study was to investigate the influence of the frozen storage temperature variation on the drip loss in broiler carcass and its impact on the functional properties of the meat.

Materials and Methods

Whole broiler carcasses (n=120), without head, neck, paws and giblets were obtained 2 hours *post mortem* from broilers of similar genetic background (Cobb/Ross). These carcasses were refrigerated through water chiller system (1 hour/5°C) and frozen by a static freezing chamber until reach –15±2°C in the middle of *Pectoralis major* (breast). After frozen process, the carcasses were divided in two groups (n=60). Each group was frozen stored during 120 days under different temperature conditions: one group was stored under low temperature variation during storage period (Control Group) and the other group was stored under high temperature variation (Critical Group). Control Group was maintained on freezer storage chamber at –15±3°C during all experimental period. Critical Group carcasses were taken from freezer storage chamber and maintained in a refrigerated chamber at 5±3°C until the temperature of the center of *Pectoralis major* (breast) reached –3±2°C (8 hours approx.). After that all samples returned to freezer storage chamber. This cyclic treatment was performed 16 times during experimental time.

The carcasses from both groups were measured for drip loss, according to Brazilian official method (Brazil, 1998). From the resulting thawed carcasses, muscle *Pectoralis major* (breast) was deboned and measured pH, surface color through Hunterlab colorimeter, in order to determine its lightness (L*), redness (a*) and yellowness (b*). As an estimative of oximyoglobin/metmyoglobin content on muscle, the ration between positive values from a* and positive values from b* was used according to proposed by Stewart (1965) and performed by Wanous (1989).

Each analysis was performed 24 times for each group at 3, 30, 60, 90 and 120 days of storage period. Data from the trials were analyzed using Analysis of Variance (ANOVA) and *Post hoc* Tukey (HSD) test, in order to determine the significance of the results in relation to temperature/time of storage.

Results and Discussion

Drip loss, storage time and temperature variation: There were significant differences ($p<0,05$) in drip loss values between Control and Critical Groups (Table 2 and Table 1). During storage time the drip loss values from Critical Group showed a significant ($p<0,05$) growing as time passed (Table 1). This growing wasn't present on Control Group (Table 2), whose values were much similar during storage time. The average temperature variation on Critical Group during experimental time was Δt=17,75°C and Δt=7,8°C for Control Group, showing a significant difference between groups. Values of drip loss from Critical Group, especially those after 60 days of storage were out of the limit of Brazilian Legislation (Brazil, 1998). Possibly the main reason for this behavior could be direct related to the extreme temperature variations in which this group was maintained. It's very clear on the scientific literature that extreme temperature variations cause recrystallization and according to Huber and

Stadelman (1970), as high as the temperature (near ice melting temperature) more intense will the recrystallization be. This phenomenon can promote the disruption of the meat fibers and other meat constituents and could be the cause of major moisture losses during thawing. The Control Group doesn't show this behavior, which can be explained by Bevilacqua and Zaritzky (1982), once when the temperature is constant, small ice crystals are formed (less than 2mm) not compromising the meat structure.

Table 1. Results from the analysis – Critical Group

Storage (days)	Drip Loss (%)	pH	L*	a*	b*	a*/b*
3	4,77 [a]	5,97 [a]	48,19 [a]	1,94 [a]	17,29 [a]	0,11 [a]
30	5,38 [a,b]	6,07 [a]	47,66 [a]	2,69 [a,b,c]	18,63 [a,b]	0,14 [a]
60	6,85 [c]	6,04 [a]	49,98 [a,b]	3,61 [c,d,e]	20,17 [c]	0,18 [b]
90	8,31 [d]	6,01 [a]	52,35 [b]	4,28 [d,e]	12,58 [d,e]	0,34 [c,d]
120	10,26 [e]	6,07 [a]	52,94 [b]	4,57 [e]	13,18 [e]	0,35 [d]

n=24 Means in the same row without a common superscript letter differ significantly (p<0,05)

Table 2. Results from the analysis – Control Group

Storage (days)	Drip Loss (%)	pH	L*	a*	b*	a*/b*
3	5,19 [a]	5,89 [a]	47,22 [a]	4,72 [a]	13,43 [a]	0,35 [a]
30	4,68 [a]	5,94 [a]	49,74 [a]	4,22 [a]	13,94 [a]	0,30 [a]
60	4,88 [a]	5,73 [b]	49,08 [a]	3,92 [a]	13,30 [a]	0,30 [a]
90	4,99 [a]	5,70 [b]	49,12 [a]	4,31 [a]	14,11 [a]	0,31 [a]
120	4,86 [a]	5,81 [a,b]	47,51 [a]	4,54 [a]	13,08 [a]	0,34 [a]

n=24 Means in the same row without a common superscript letter differ significantly (p<0,05)

Color, pH and oximyoglobin/metmyoglobin content: There were no significant differences in pH values between Critical and Control Groups and in relation to storage time (Tables 1 and 2). There was a slight tendency of lightness, redness and oximyoglobin/metmyoglobin ratio increase during storage time in Critical Group. This maybe explained by the possible disruption of the meat fibers, releasing increasing amounts of moisture and natural meat pigments, causing a major reflectance (lightness) and redness, influencing the oximyoglobin/metmyoglobin ratio.

Conclusions

The findings validate the hypothesis that high temperatures variation during frozen storage can lead to higher moisture/meat constituents losses, causing economical, quality and legal prejudice. The results indicate the need of more and deep studies on this matter and its impact on the legislation.

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